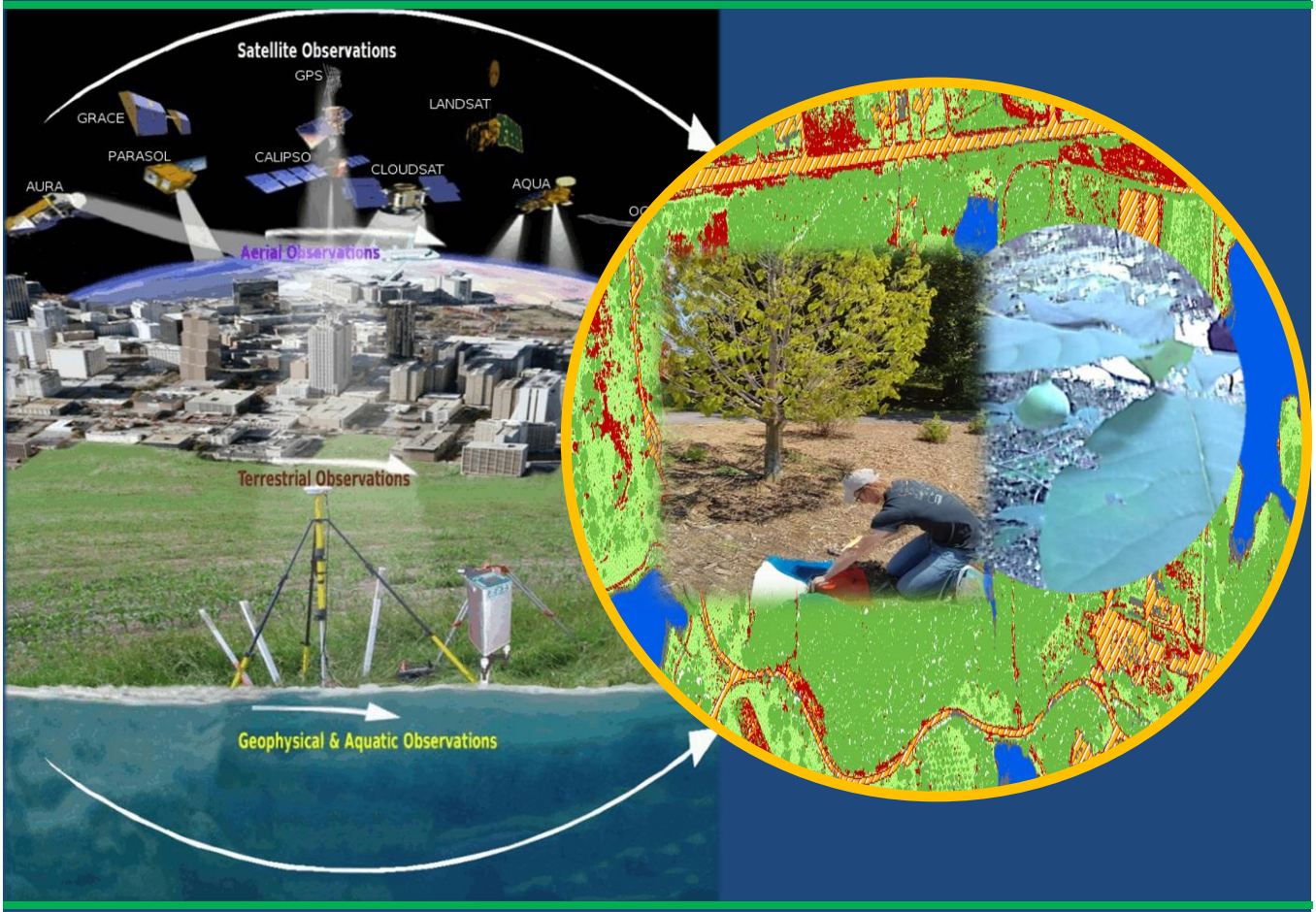
MAPPING THE SPATIAL DISTRIBUTION OF PAWPAW IN KENTUCKY – PILOT SITE GUERILLA CREEK



Authors: B. Acharya, K. Pomper, B. Gyawali, K. Bhattarai, A. Berry, T. Tsegaye

ABSTRACT

Native pawpaw patches serve an important role in forest ecosystems around streams and rivers in terms of fruit production, soil erosion control, enhancing insect biodiversity, and possibly resisting establishment of invasive plant species. Field observations at several locations in Kentucky suggest that areas where pawpaws are well established tend to have a presence of fewer invasive plant species. How pawpaw patches have spread throughout the southeastern United States is not well understood. The objective of this study is to find a suitable model(s) to map spatial concentration of pawpaw patches and invasive species in central Kentucky utilizing multitemporal imageries captured from airborne and satellite platforms. Upscaling and down scaling of multi-temporal-spectral-spatial existing imageries are used to develop the model(s). Multispatial resolutions airborne imageries from 5-cm to 100-cm, and satellite imageries of 15-meter are tested. Multispectral: panchromatic, color-color infrared, near infrared imageries collected during different time covering the Guerilla Creek watershed at Bernheim Arboretum and Research Forest as a pilot site are used. A priori spectral signatures of pawpaw, spicebush, and other plants will be used during the model development for creating vegetation indices, measure density, slope, aspects, crown diameter, and height. The model developed at this pilot site will be expanded to cover other areas such as the central Kentucky region.

- MULTI-TEMPORAL-SPECTRAL-SPATIAL
- GUERILLA CREEK AT BERNHEIM ARBORETUM
- IMAGE CLASSIFICATIONS
- SPATIAL DISTRIBUTION OF PAWPAW
- RESULTS
- ACCURACY STANDARDS

RESEARCH LOCATION

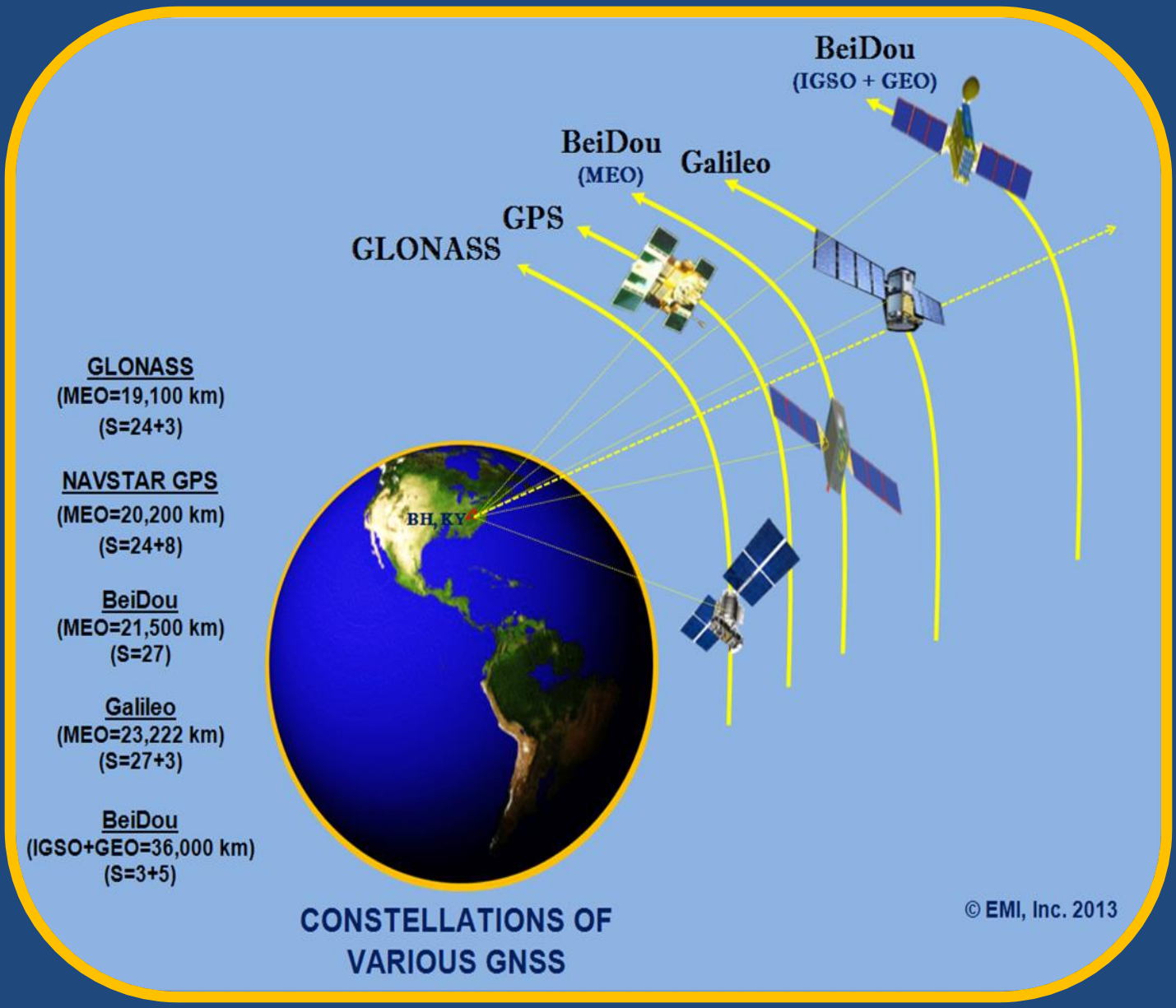
Source: Google + Bernheim+ US Census + EMI

GNSS GEODETIC NETWORK – OPUS STATIC

BERNHEIM ARBORETUM
&
RESEARCH FOREST

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)
ONLINE POSITIONING USER SERVICE (OPUS)

VARIOUS GNSS

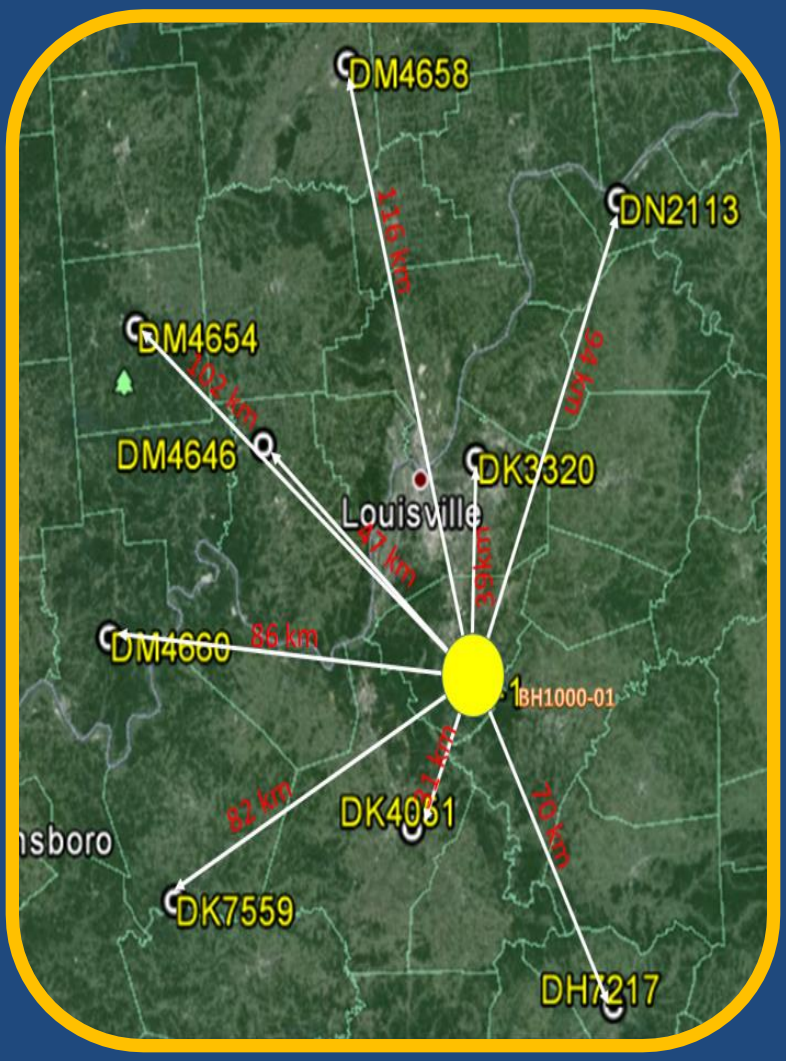


ALL NAVIGATION SATELLITES HAVE MEDIUM EARTH ORBITING (MEO) CONFIGURATIONS EXCEPT BEIDOU SYSTEM

BEIDOU NAVIGATION SATELLITE SYSTEM HAS THREE DIFFERENT ORBITS:

MEO,
INCLINED GEOSYNCHRONOUS SATELLITE ORBIT (IGSO), &
GEOSTATIONARY EARTH ORBIT (GEO)

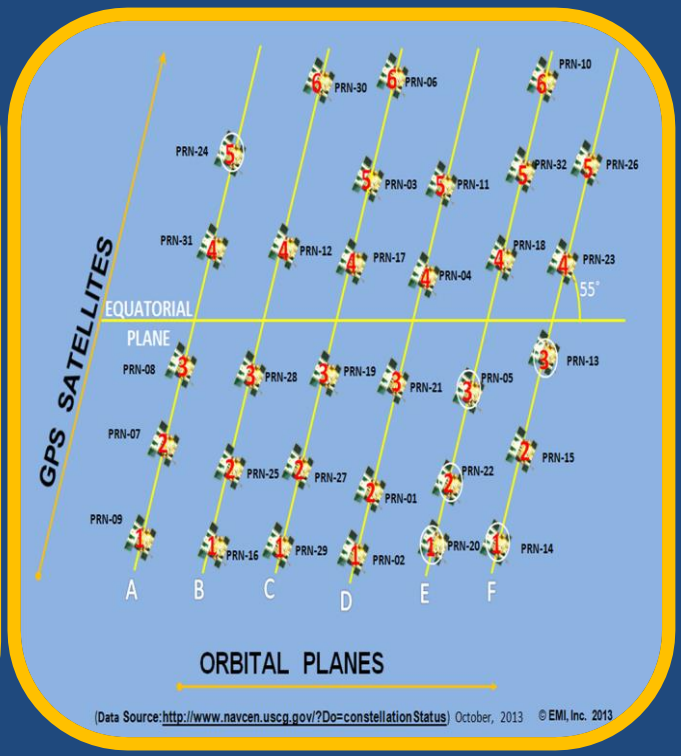
OPUS RAPID STATIC NETWORK COMPUTATION



NGS OPUS-RS SOLUTION REPORT
==========
All computed coordinate accuracies are listed as 1-sigma RMS values.
For additional information: http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy
USER: bishwa@earthmapping.com DATE: March 30, 2013
RINEX FILE: 1776072u.13o TIME: 01:30:27 UTC
SOFTWARE: rsgps 1.37 RS94.prl 1.87 START: 2013/03/13 20:41:00
EPHEMERIS: igs17313.eph [precise] STOP: 2013/03/13 21:01:30
NAV FILE: brdc0720.13n OBS USED: 1278 / 1494 : 86%
ANT NAME: TRMR8_GNSS3 NONE QUALITY IND. 25.64/ 6.65
ARP HEIGHT: 2.00 NORMALIZED RMS: 0.304
REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.19690)
X: 381579.972(m) 0.004(m) 381579.181(m) 0.004(m)
Y: -5023243.164(m) 0.029(m) -5023241.739(m) 0.029(m)
Z: 3898876.369(m) 0.024(m) 3898876.262(m) 0.024(m)
LAT: 37 55 26.59945 0.007(m) 37 55 26.62623 0.007(m)
E LON: 274 20 38.43321 0.003(m) 274 20 38.40534 0.003(m)
W LON: 85 39 21.56679 0.003(m) 85 39 21.59466 0.003(m)
EL HGT: 127.554(m) 0.037(m) 126.321(m) 0.037(m)
ORTHO HGT: 160.895(m) 0.039(m) [NAVD88 (Computed using GEOID12A)]
UTM COORDINATES STATE PLANE COORDINATES
UTM (Zone 16) SPC (1600 KY1Z)
Northing (Y) [meters] 4198240.471 1176546.346
Easting (X) [meters] 618124.681 1508264.785
Convergence [degrees] 0.82614564 0.05771797
Point Scale 0.99977186 0.99990529
Combined Factor 0.99975185 0.99988528
US NATIONAL GRID DESIGNATOR: 16SFG1812498240(NAD 83)

BASE STATIONS USED

DK4051 KYTD KY HWY DIST 4 CORS ARP N374054.459 W0855102.411 31890.9
DK3320 KYTE KY HWY DIST 5 CORS ARP N381635.939 W0853554.200 39463.0
DM4646 INFC FALLS CITY CORS ARP N382048.315 W0854458.830 47633.4
DH7217 KYCP CAMPBELLSVILLE U CORS ARP N372032.022 W0852100.223 69996.9
DK7559 KYRR ROUGH RIVER SRP CORS ARP N373635.880 W0863008.698 82324.7
DM4660 INTC TELL CITY CORS ARP N380336.152 W0863732.842 86517.1
DN2113 KYBU GEN BUTLER SRP CORS ARP N384025.770 W0850917.721 94063.4
DM4654 INPA PAOLI CORS ARP N383357.706 W0862930.634 102136.9
DM4658 INSY SEYMOUR CORS ARP N385736.280 W0855142.432 116399.4



AERIAL MISSION PLANNING

Digital Metric Mapping Camera	
Final Resolution	5-cm
Flying Height	2700’ AGL
Aerial Targets	22” x 22”
Ground Control Points	9
Ground Sampling Distance (GSD)	1.97”
LiDAR Data GSD	1-meter

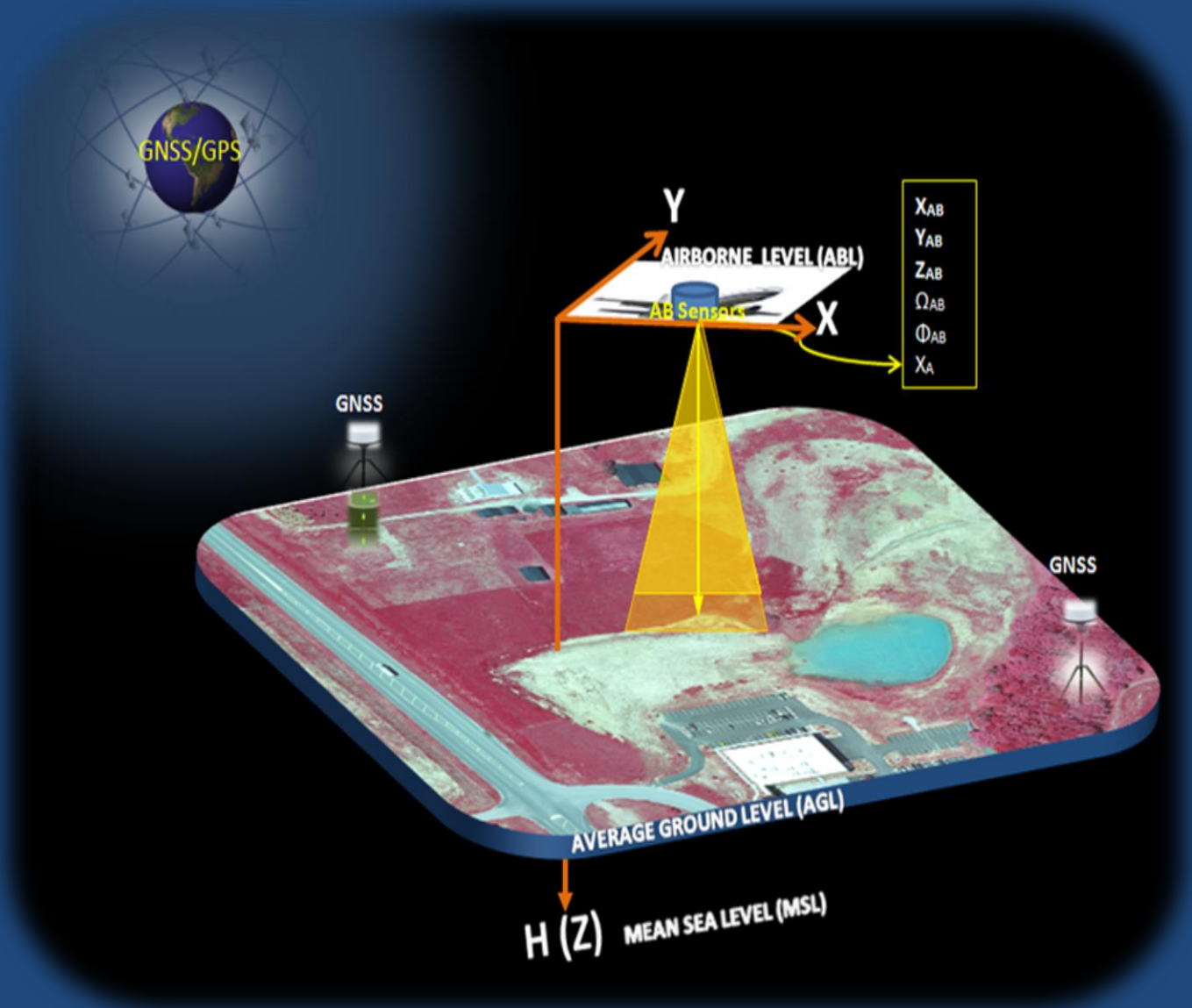
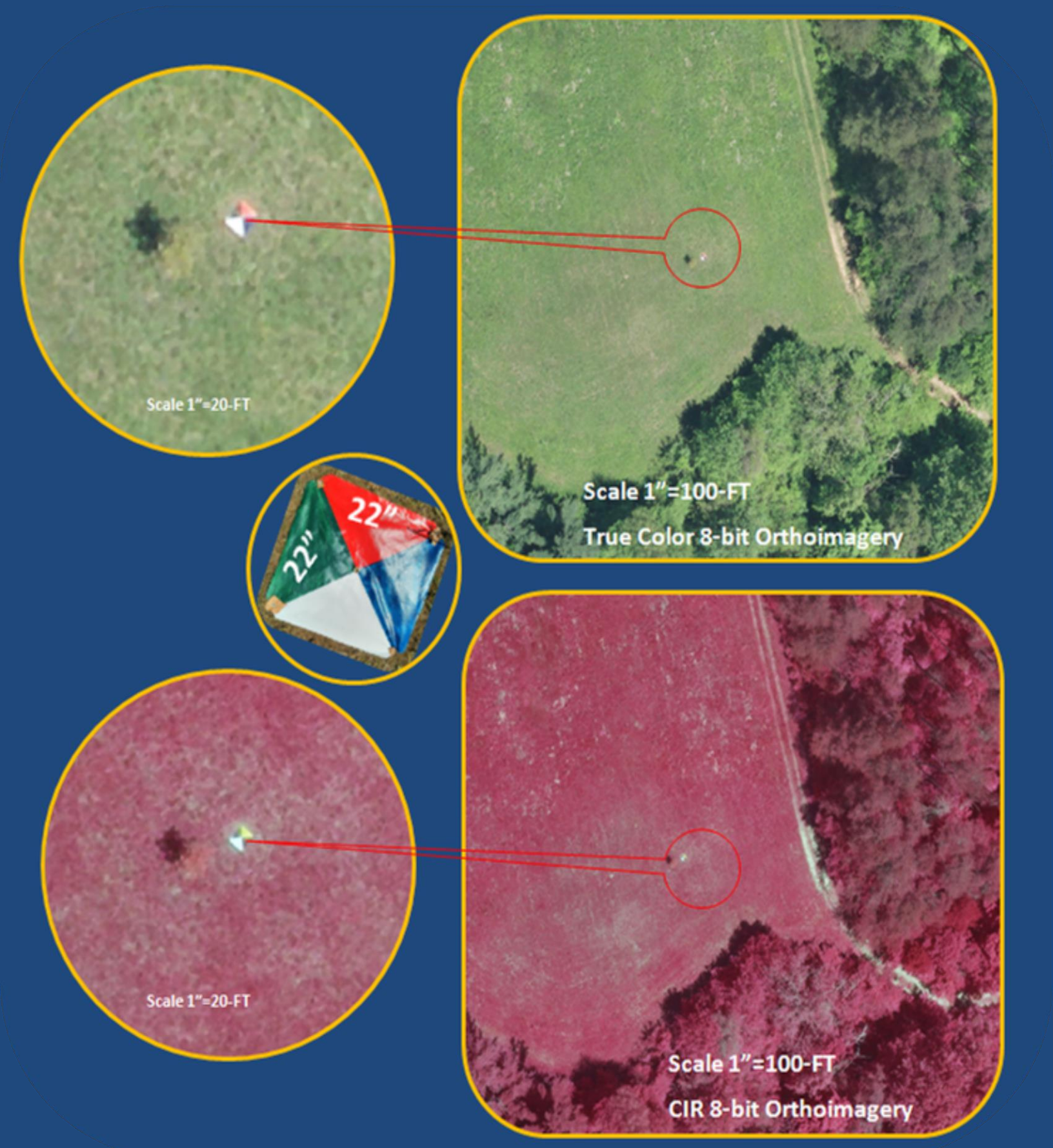


PHOTO CONTROL POINTS FOR BERNHEIM RESEARCH (GUERILLA CREEK) SITE

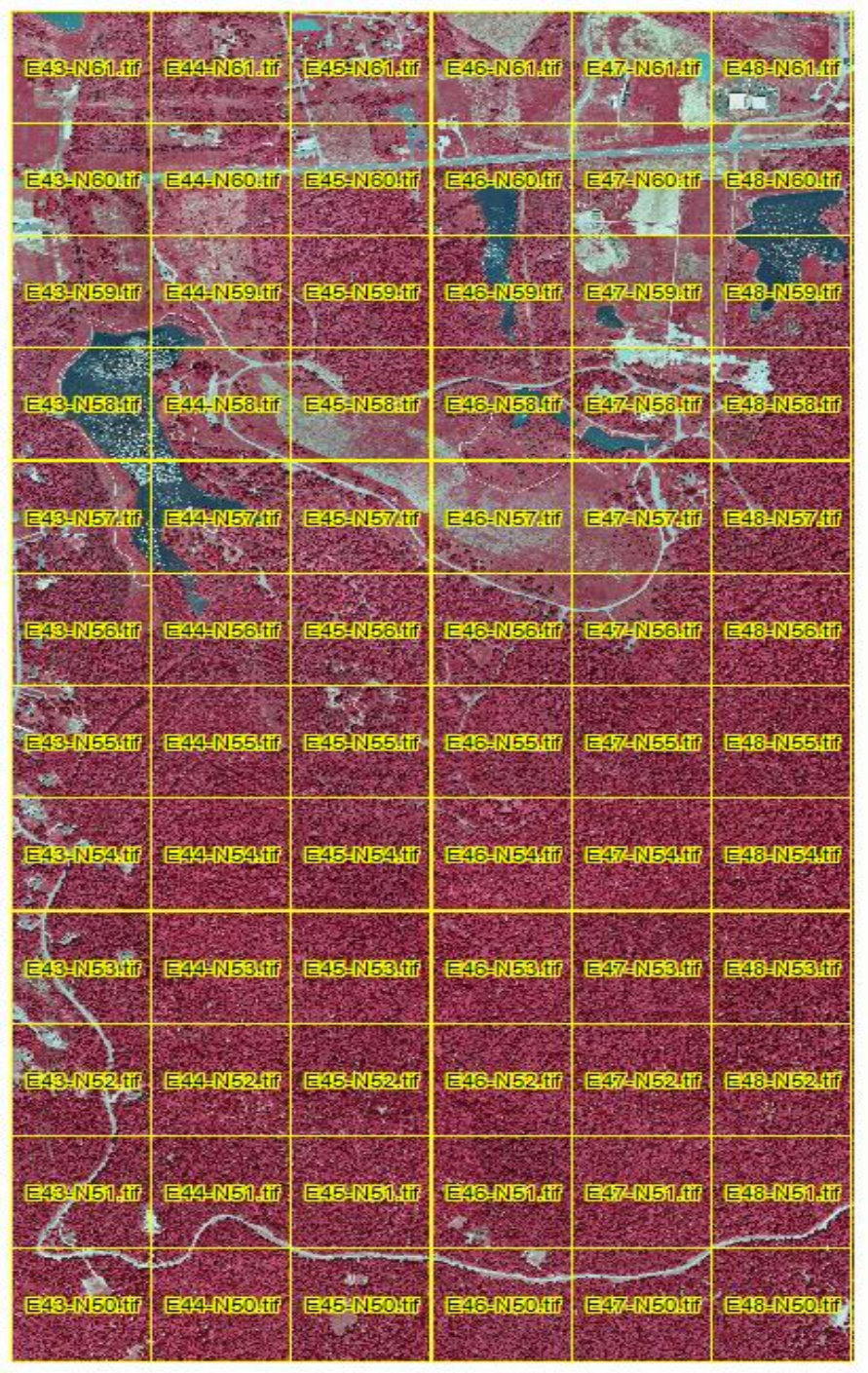
NEW AERIAL TARGETS DESIGNED AND USED FOR COLOR AND CIR MULTISPECTRAL MAPPING

AERIAL TARGETS & RESOLUTION ISSUES



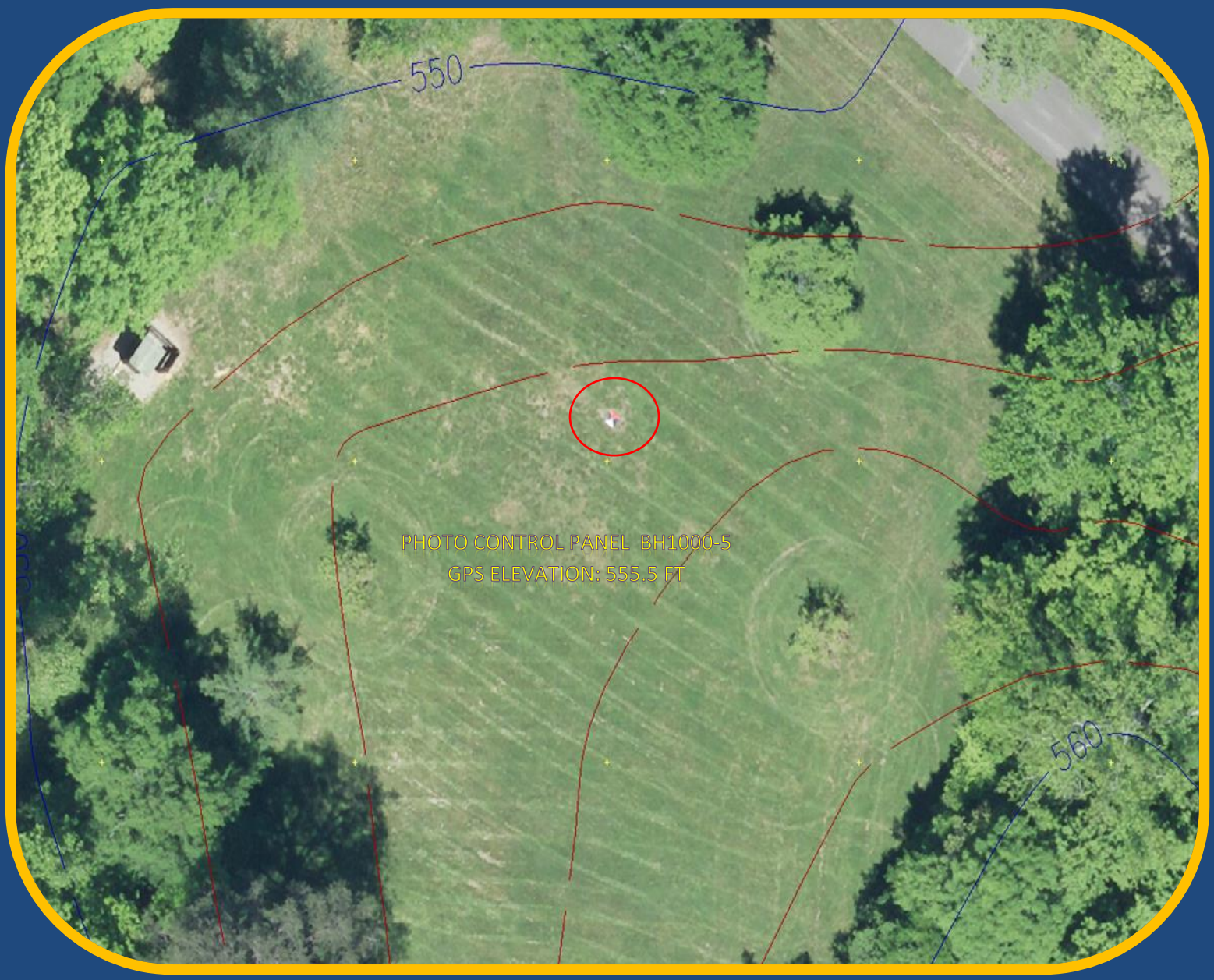
AERIAL TARGETS VISIBLE IN COLOR AND CIR IMAGERIES

DATA PROCESSING & GENERATION



4 Lines 101 Exposures 1.97 " GSD
72 Tiles of Color and CIR Orthophotos
5-cm Resolution
LiDAR Data 1-m Resolution
9-Photo Control Points Used for AT

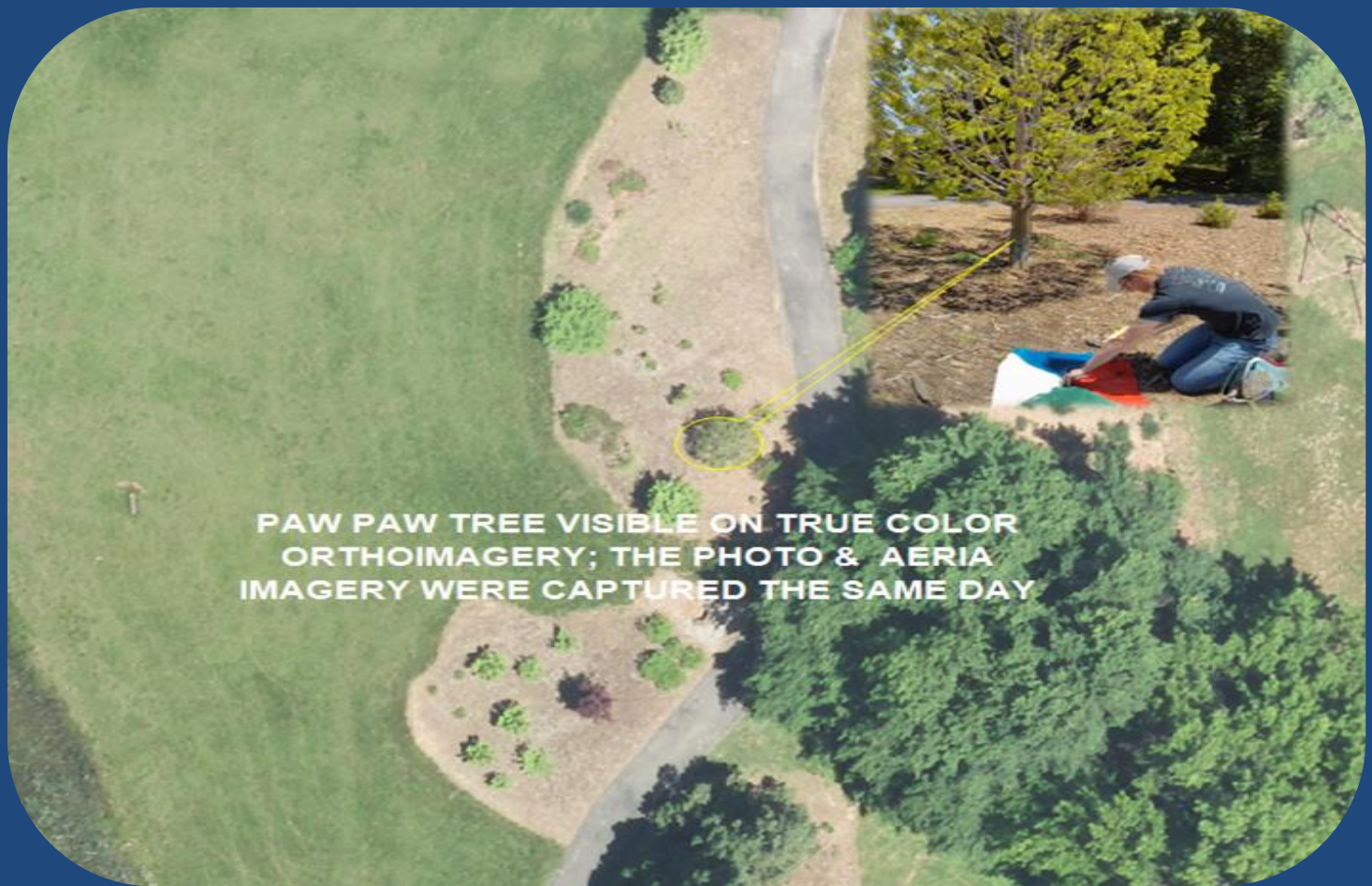
ACCURACY STANDARDS



Static OPUS HARN Point Precision	**1- cm**
Photo Control Points (Rapid Static)	3-cm
5-cm Resolution Ortho Imagery Accuracy Estimate	
a priori RMS	~ 15-cm
a posteriori RMSE	12.14-cm
LiDAR Topographic Data Accuracy Estimate	
a priori RMSE	Unknown
a posteriori RMSE	15-cm

PAWPAW TREES IN KENTUCKY

PAWPAW TREES IN BERNHEIM KENTUCKY



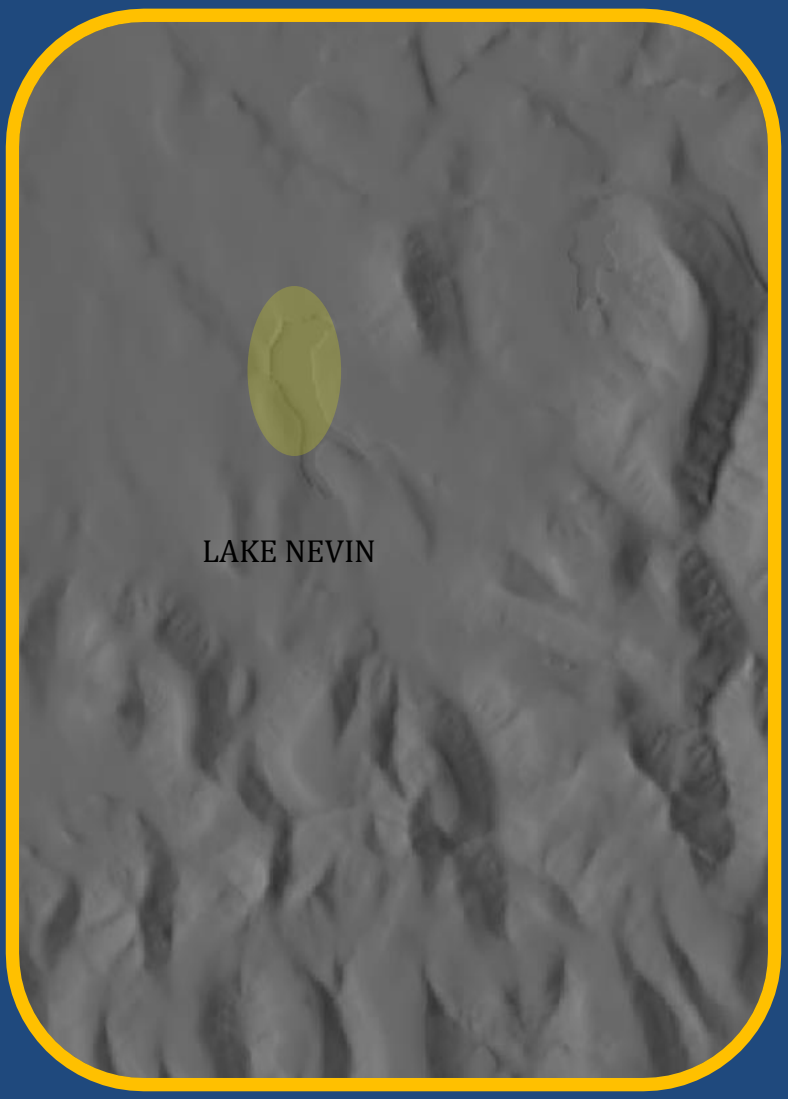
PAWPAW TREES AT BERNHEIM, KENTUCKY CONT'D..

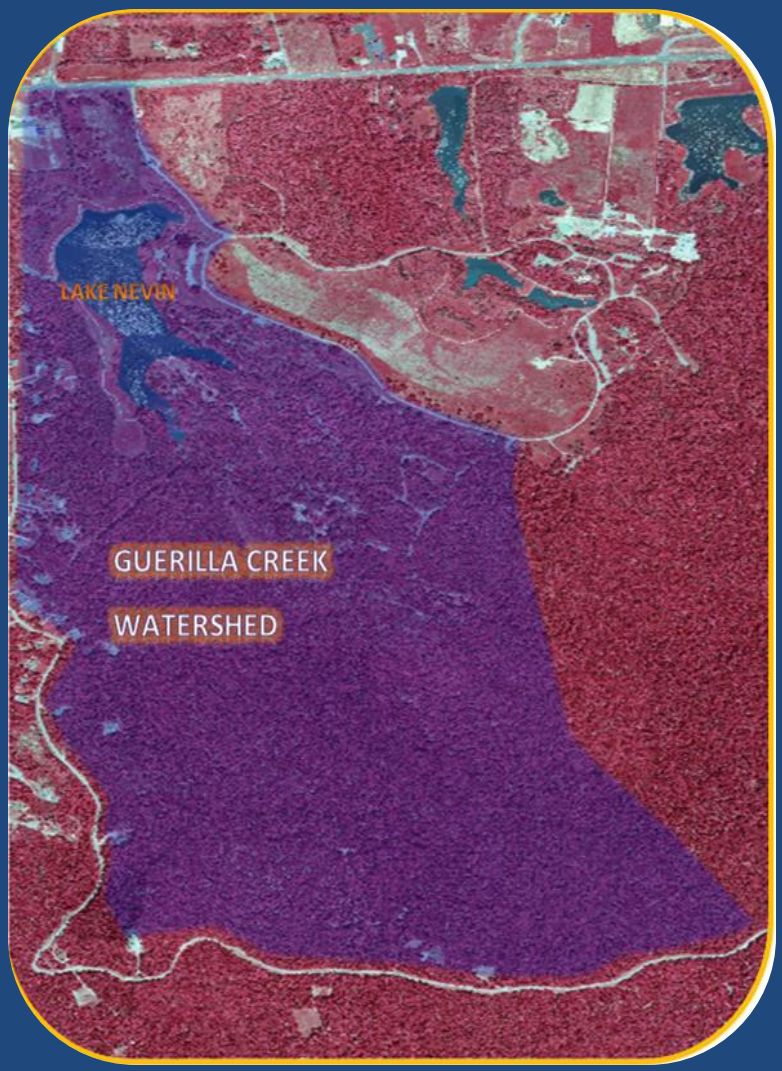
PAWPAW TREES ARE FOUND ALONG CREEK AREAS SUCH AS THE HIGHLIGHTED AREA ABOVE IN THE GUERILLA CREEK WATERSHED

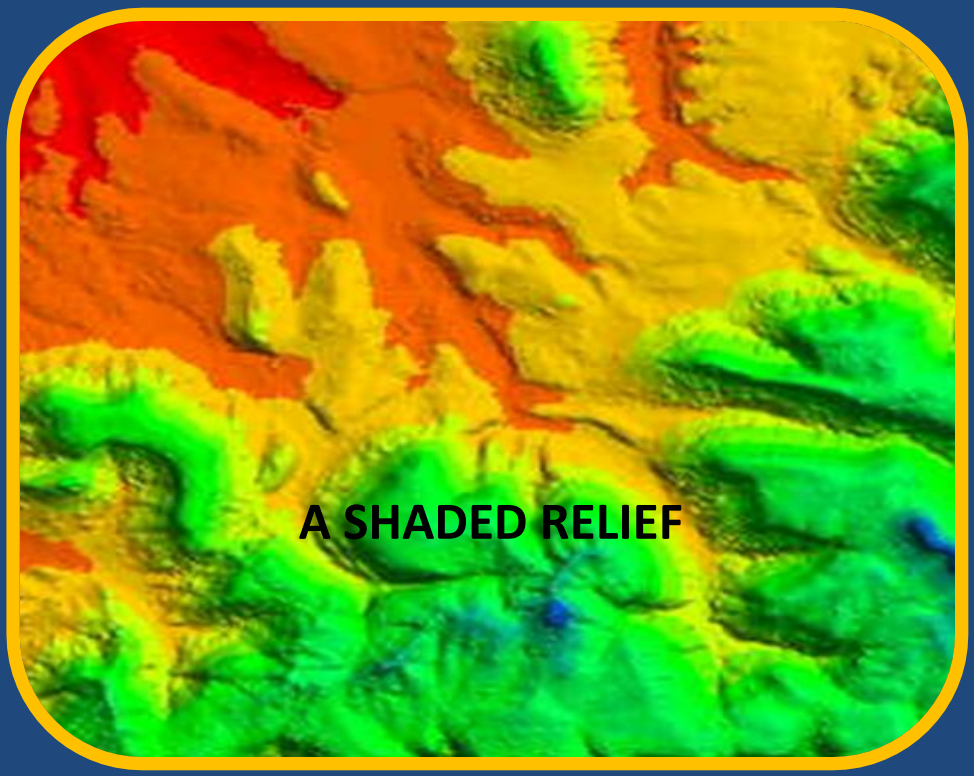
PAWPAW TREES AT BERNHEIM, KENTUCKY CONT'D..

GROWN ALONG CREEKS AS UNDERSTOREY TREES
(PICTURE JULY 2014)

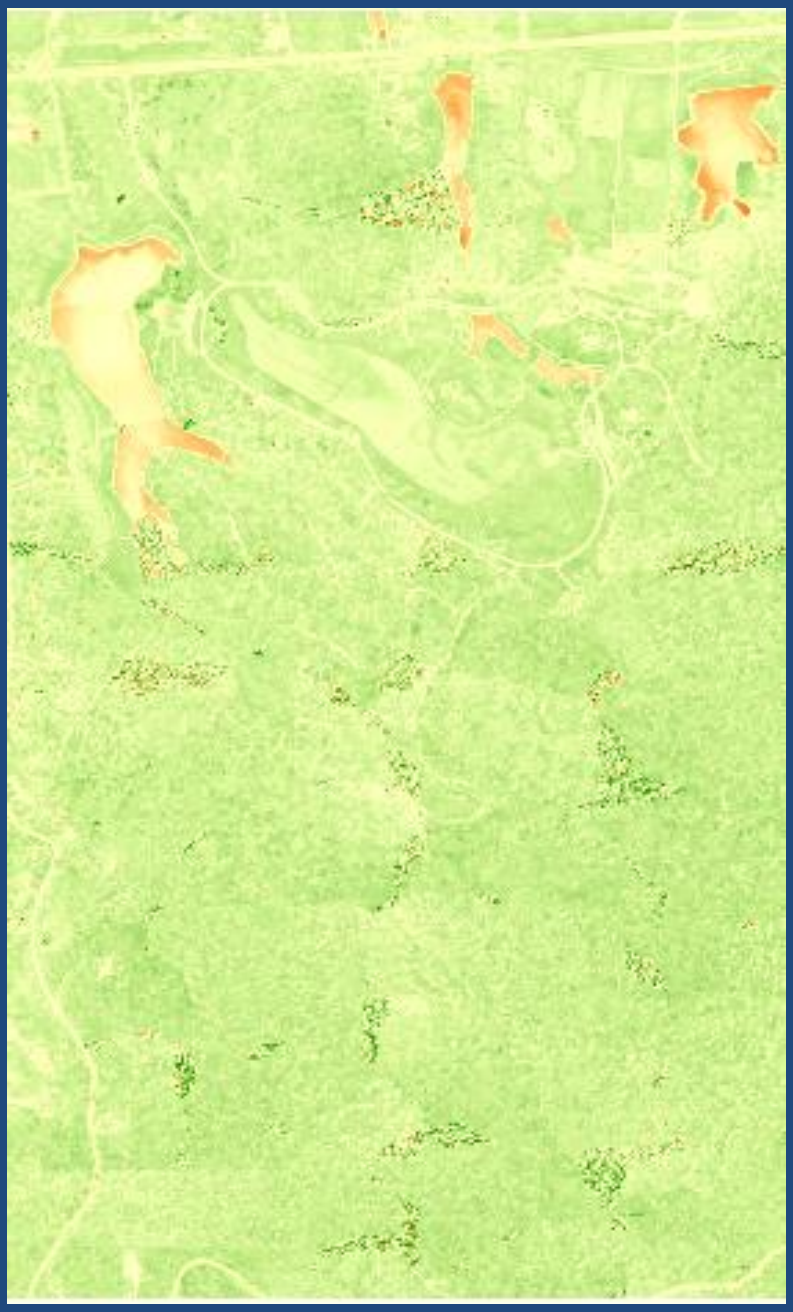
GUERILLA CREEK WATERSHED ELEVATION DATA



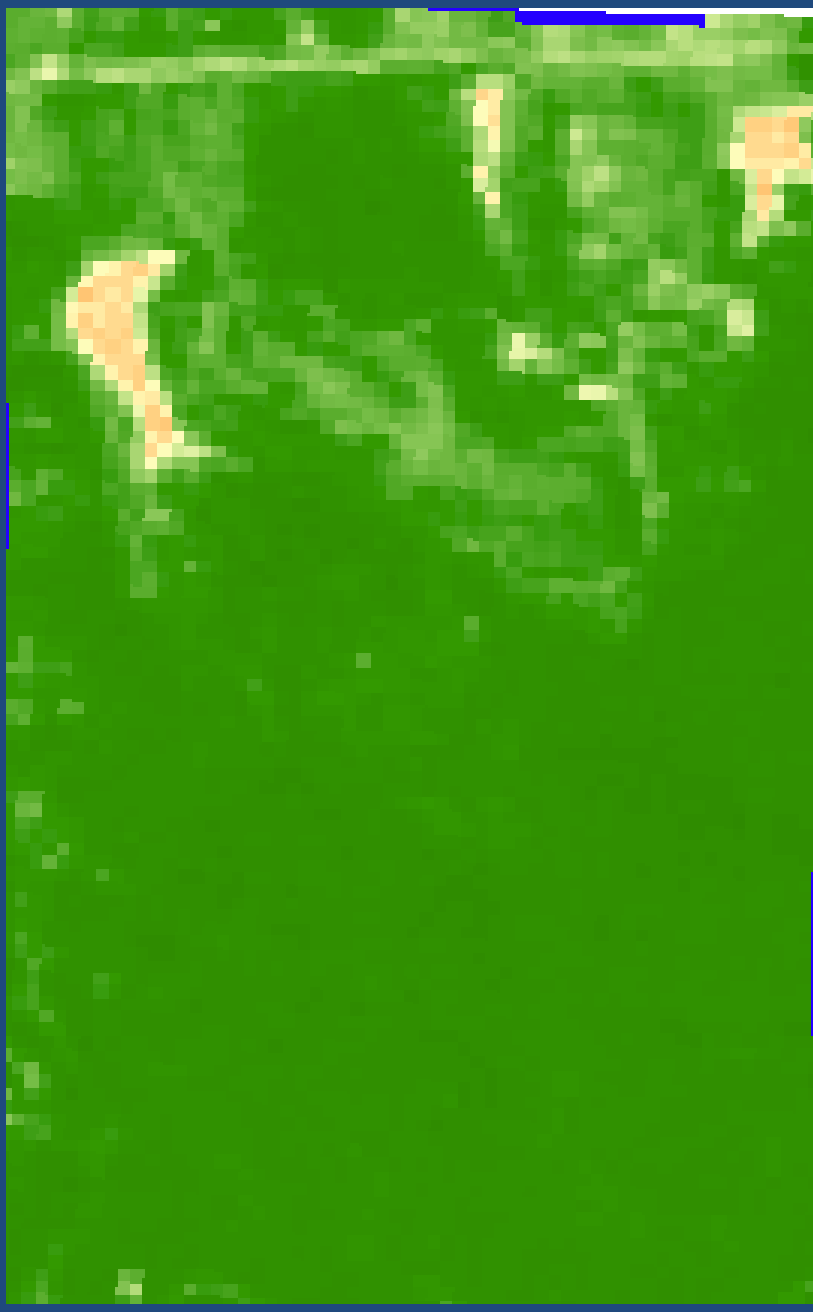




GUERILLA CREEK WATERSHED NDVI DATA



NDVI from 5-cm Ortho Mosaic

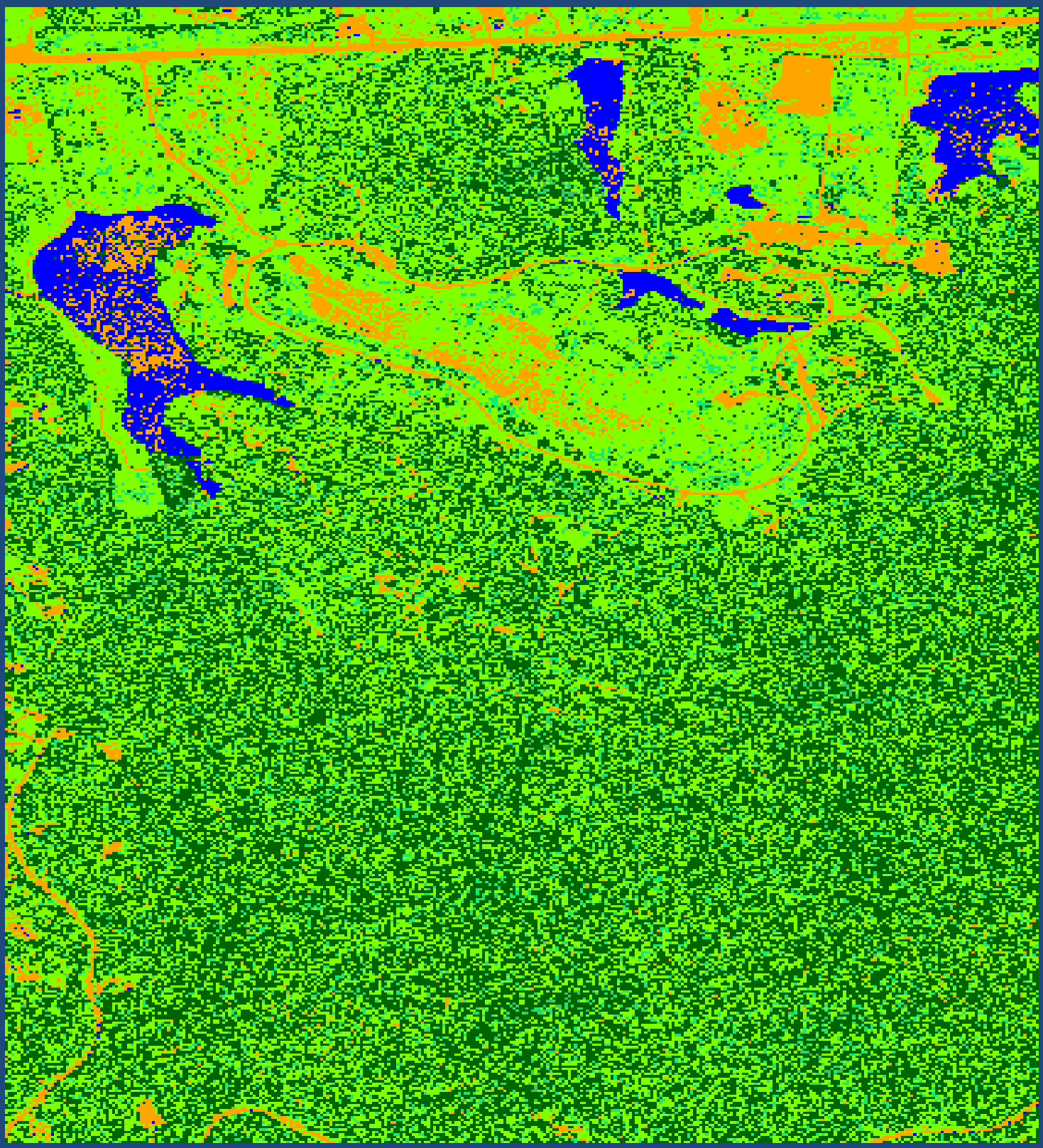


NDVI from 15-m LANDSAT ETM

NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) assists in checking the density of vegetation for any area of interest.

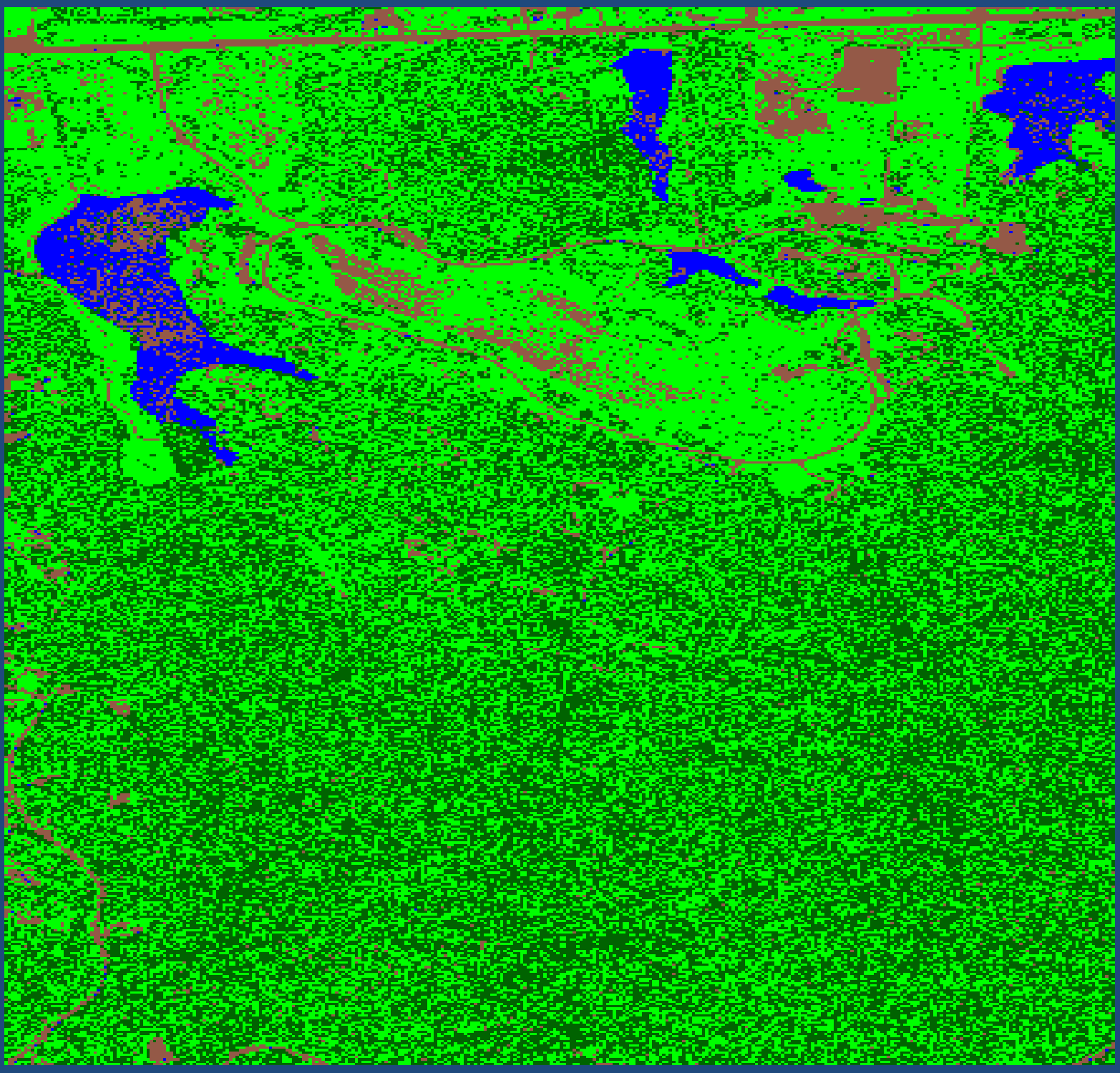
NDVI = (NIR – VISIBLE RED) / (NIR + VISIBLE RED)

GUERILLA CREEK STUDY AREA IMAGE CLASSIFICATION



UNSUPERVISED CLASSIFICATION WITH 60 CLASSES

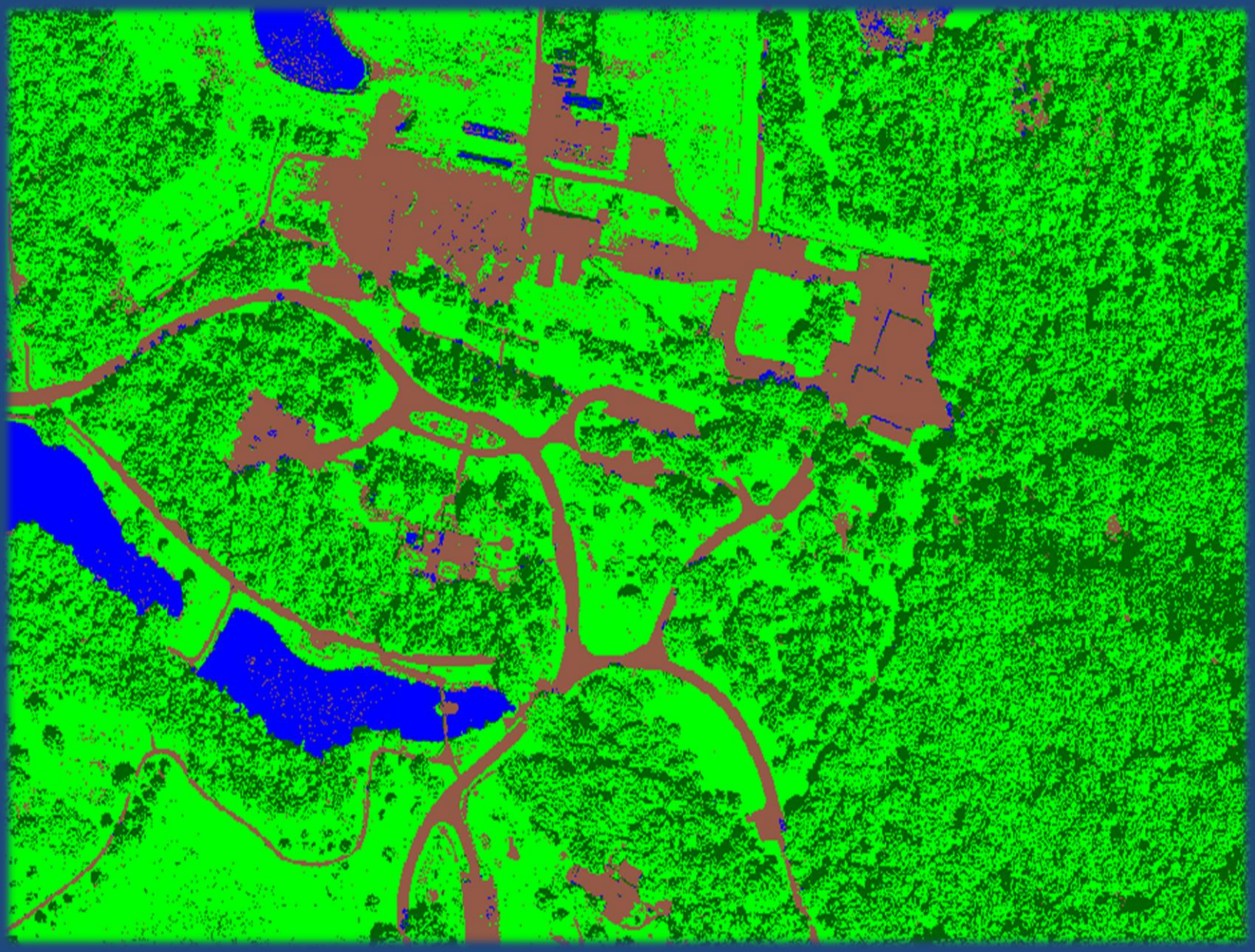
GUERILLA CREEK STUDY AREA IMAGE CLASSIFICATION CONT'D.



RECODED 4 CLASSES FROM THE 60 CLASSES:

1. Impervious
2. Trees
3. Grass
4. Water

GUERILLA CREEK STUDY AREA IMAGE CLASSIFICATION CONT'D.



Zoomed in Image

Recoded 4 Classes From The 60 Classes:

1. Impervious Surface
2. Trees
3. Grass
4. Water

PROBLEMS

Both supervised and unsupervised classifications could not trace the pawpaw trees.

Despite the high resolution of the ortho imagery used , the classification techniques could not create a separate class of pawpaw.

The Near IR is not good enough to separate spectral signature of pawpaw with other vegetation.

Majority of pawpaw trees in the study area are located under story or under the canopy of taller trees.

NEXT STEPS

PERFORM THE FOLLOWING TO OVERCOME THE PROBLEMS:

FLY THE STUDY AREA WITH HYPERSPECTRAL SENSOR

PERFORM A GROUND X-SECTION & L-SECTION SURVEYS ALONG THE GUERILLA CREEK (TERRESTRIAL LiDAR ALONG WITH TERRESTRIAL IMAGERIES OF PAWPAW PATCHES)

CAPTURE HIGH INTENSITY AIRBORNE LiDAR DATA & AIRBORNE IMAGERY

INTEGRATE AIRORNE LiDAR INTENSITY, FIRST RETURN, LAST RETURN, INTERMEDIATE RETURN, AND TERRESTRIAL IMAGERIES TO CAPTURE SPECTRAL SIGNATURES FROM THE UNDERSTOREY PAWPAW TREES

COLLECT DIGITAL SPECTRAL SIGNATURES OF VARIETIES OF PAWPAW TREES AVAILABLE AT THE STUDY SITE

PERFORM CLASSIFICATION BUNDLING THE IMAGERIES FROM VARIOUS SENSORS

USE THE GROUND COLLECTED DATA FOR GROUND TRUTHING

UTILIZE THE SPECTRAL SIGNATURES OF THE VARIOUS PLANT SPECIES TO PERFORM A SUPERVISED CLASSIFICATION

CONCLUSIONS

THE CURRENT ONGOING STUDY GUIDES TOWARDS THE NEXT STEPS TO OVERCOME THE PROBLEMS.

THE DATA SO COLLECTED WILL BE USEFUL FOR OTHER APPLICATIONS SUCH AS IMPERVIOUS SURFACE MAPPING, ENGINEERING MAPPING, LAND USE/COVER MAPPING, SOIL MAPPING, AND WATERSHED STUDIES.

ACKNOWLEDGEMENTS

THE RESEARCH TEAM ACKNOWLEDGES THE KENTUCKY STATE UNIVERSITY FOR PROVIDING PARTIAL RESEARCH FUNDING AND BERNHEIM ARBORETUM AND RESEARCH FOREST FOR THE LOGISTICS PROVIDED DURING THE FIELD WORK OF THIS RESEARCH.

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THANK YOU FOR YOUR ATTENTIONS & PARTICIPATIONS!